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ANNUAL REPORT

1946

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION[1/]

Berkeley, California

Stephen N. Wyckoff, Director

Not for publication

1/ In cooperation with the University of California

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ANNUAL REPORT OF THE

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION[1/]

1946

FOREWORD

The year 1946 brought several changes in the scope and direction of the Station program. Some of them aided the program by strengthening research in a few divisions; others decelerated Station activities, slowing progress toward recognized objectives.

Flood Control Surveys Resumed

During the first half of the year Flood Control Survey activities were resumed with Ilch appointed to head up the expanding program. His first tasks included planning for the resumption of surveys on July 1, when Flood Control Surveys were set up as a separate division. Although this development brought no change in the broad objectives of pre-war surveys, reorganization of the Flood Control work within the Department brought with it certain modifications in policies. The scope of the present program is limited to those activities leading up to and including the preparation of watershed reports which recommend for or against a Department of Agriculture program in aid of flood control. This Station has been assigned the State of California, except for the Russian and Salinas Rivers, which are assigned to the Soil Conservation Service; minor east side drainages in Nevada; the lower and upper Columbia River basins; and the coast streams of Oregon and Washington.

Division of Forest Economics Reorganized

Early in the year the Division of Forest Economics was reorganized to include work of the Forest Survey, the Lumber Census and Requirements, and the Products and Supplies (R.P.S.) with the work formerly assigned to Forest Economics. This merging of related activities into one administrative division has brought about greater strength, more effective assignment of staff members and prevention of duplication.

Forest Survey Started

July 1, 1946 saw the inception of the long awaited Forest Survey in California. All possible preparation had been made prior to that date, an effective staff selected, and work was started as soon as funds were available. Excellent progress has thus far been made. However, there are unfavorable elements in the situation which may cause public

1/ Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California at Berkeley, California.

dissatisfaction and criticism at a later time, and should now be fairly faced. The combination of a brutally short time limit for completion of the inventory phase and insufficient total funds available for the undertaking - greatly aggravated by the devaluation of the research dollar - may well result in a product far short of that which the public has been led to expect from the Forest Survey. Such public dissatisfaction might result in the allocation of additional funds by other agencies or levels of government, as is now being considered by the State of California. But we must not be blind to the possibility of criticism of the "thinness" of the inventory data resulting from too little time and money.

Forest Management, Range, and Influences Research Strengthened

Additional funds allocated to these three divisions made possible some expansion of the research programs. Forest Management Research benefited by the employment of three additional men, materially speeding up the Division's program, and by the limited strengthening of the Forest Genetics program. Additional temporary and permanent workers in Range Investigations assisted the Division's program, and brought nearer the publication of important results, planned for the near future. An increased allotment on July 1 for Influences work in the Sacramento River Basin enabled the Division to reemploy Munson during the latter half of the year by transfer from his wartime assignment at the Forest Products Laboratory. Before Munson transferred back to the Forest Products Laboratory at the end of the year he assembled a mass of information aimed at a problem analysis for Forest Influences Research in the Sacramento River Basin. Other increases also buttressed the financing of the San Dimas staff as emergency funds failed.

The Research Dollar Has Been Devaluated

The decreased amount of services and materials which can now be purchased by each dollar appropriated for forest research must be taken into account realistically in program planning and in evaluation of progress toward objectives. This depreciation is evident in increased costs of travel, particularly in costs of operation and upkeep of motor vehicles, the 14 percent pay increase, and in the steady rise in cost of all supplies, materials and equipment. Until allocations of funds are increased proportionately or these increased costs lowered, a lower output of results must be expected. This situation has been mentioned with special reference to the Forest Survey; it applies with equal force to the work of all other divisions.

The Emergency Programs are Terminated

Since its period of greatest expansion in the early 1930's, this Station has operated continuously with the help of such emergency programs as the CCC, WPS, CWA, and CPS. These programs have provided funds for considerable numbers of sub-professional workers in the field and as computers and other types of office workers, salaries for a number of the technical staff who were supervising the emergency workers, and, perhaps most importantly, the funds for labor and materials to operate and maintain the experimental forests. The last of these programs, the CPS, was terminated at the end of the year, and for some time before that date the efficiency level of the

conscientious objectors had been so low as to render their services of almost negligible value. It is most difficult to place a definite dollar value on the services provided by the emergency programs. But it can be said that their termination is raising serious policy questions as to the scope of the research program and the maintenance of the experimental forests, particularly the San Dimas Experimental Forest and the San Joaquin Experimental Range, where the emergency programs have been of greatest aid in the past few years. The answers may leave only a choice between using much of the time of highly skilled and paid technical workers for low grade maintenance work and the closing down of these experimental centers.

The Nature of This Report

The report of this Station for the calendar year 1946 differs from those of previous years in that it attempts to set up a research ledger. Each divisional report first states the objectives for 1946 as given in the 1945 report. It then discusses the work performed and highlights the most significant results for each item under the plan. Finally it lists the plans for 1947. Those plans are designed to serve as a similar framework for the 1947 report when it is prepared next year. It is hoped that this organization of the Station annual reports will simplify determination of the rate of progress on definite assignments. Such a report is obviously unsuitable for distribution to the public, and this report is designed only for in-Service use.

FOREST MANAGEMENT RESEARCH
(Duncan Dunning, Chief of Division)

Objectives

In 1946 forest management research was directed toward two general objectives: (1) making the results of 35 years of research available for rapidly expanding forestry enterprises, and (2) starting or strengthening research on those phases of forestry currently increasing in importance.

Specific projects planned were:

1. Continue the ponderosa pine harvest cutting experiment at Blacks Mountain.

2. Rehabilitate the most important older plots to obtain growth and loss data needed in management plans and in the Forest Survey.

3. Revise growth predicting charts for pine types.

4. Amplify the redwood growth study to the extent required in the Forest Survey.

5. Revise the more important volume tables.

6. Summarize collected records on past planting research.

7. Summarize accumulated silvicultural data in the form of brief recommendations for desirable practices.

8. Continue assistance to management agencies.

Activities and Accomplishments

Degree of success attained during the year was considerable though far from complete. Making results of past studies available involved re-examining and analyzing records from more than 1600 acres of logging and cultural experiments, some dating back to 1910; sampling surveys of some 26,000 acres of plantations dating from 1930; and extracting new information from volume table and growth records accumulated since 1902. The dimensions of these tasks restricted action on the second general objective to preparation of working plans, with field work deferred until the last half of the fiscal year starting July, 1946.

Efficient crew organization and training made it necessary for all members of the Division to work on several studies during the year. W. E. Hallin directed the silviculture-management phases; V. A. Clements, the mensuration projects; and H. A. Fowells, forestation studies.

Simplified procedures and an efficient young crew enabled finishing most of the projected field work and the bulk of record

analysis. Partial restoration of funds also helped. On the unfavorable side were loss of four experienced men and the necessity of training new men, making it necessary to defer work on the redwood growth study. Specific projects or phases completed were:

1. Harvest Cutting at Blacks Mountain

The Blacks Mountain ponderosa pine conversion cutting experiment was extended by 767 acres, producing 4,762 M B.M. of logs. The cut since 1937 now totals 41,755 M board feet. Operations included final removal harvest cutting on 355 acres, preparatory to stand improvement in fully stocked advance growth; combined insect control-salvage and release cutting on 333 acres; and plot cutting experiments on 79 acres.

The ninth of the proposed ten series of plot tests on methods of cutting was established, and the four series that have run five years were re-measured.

Five-year records from these four cutting series showed:

Method of cutting	Losses, bd. ft. per acre	Net growth, bd. ft. per acre
Virgin timber (control)	91	16
Insect control cutting	9	134
Blacks Mountain cutting	13	97
Current Forest Service cutting	9	80
Former Forest Service cutting	7	67
Very heavy cutting	1	48

Insect losses on the experimental forest as a whole were again relatively low, as shown by the annual survey conducted by the Bureau of Entomology and Plant Quarantine.

The cutting budget for the experimental forest is being revised in accordance with findings of the first 10 years. The unexpected efficiency of insect control-salvage cutting and lower than expected costs of light, variable cutting warrant attempting to carry a higher proportion of the mature stand for longer periods than was at first thought possible. The continued failure of seed crops influence this decision to some extent. These factors enable adjusting the cut for progressive improvement in net growth while avoiding the future extreme reduction or even discontinuance of logging that first seemed necessary because of the deficiency of intermediate age and size classes.

2. Older Harvest Cutting Plots

Examination of the larger series of older harvest cutting plots in mixed stands was begun July 1 and was completed by September 30. Compilation was directed first to growth data urgently needed in the Forest Survey. Besides aiding Survey work, these long-term studies supply information needed to revise cutting practices and growth estimates for land managers.

Important basic information provided by the 1946 study includes: (1) growth and loss, as related to species composition, tree class, site, volume in the reserve, and method of cutting; and (2) such supplementary information as seed production, cause of damage, brush invasion, etc.

Loss prediction charts based on 35-year records of permanent plots will be particularly valuable to the Forest Survey, as will growth prediction data for pine, pine-Douglas fir-fir, and pine-fir types.

3. Growth Prediction

Preliminary summaries based on 429 acres of the plots indicate that endemic losses of all kinds probably will average considerably higher than was estimated from the first 20-year records. On the other hand, in-growth for the longer term apparently will exceed earlier estimates. Actual and estimated growth of the merchantable reserve agreed quite closely; hence, the compensating loss and in-growth deviations resulted in a very close estimate of net growth -- 231 bd. ft. to the acre annually as compared with actual growth of 226 bd. ft. Short-term periodic estimates, at first glance, appear to offer means of improving forecasts of losses and in-growth.

A disturbing upward trend of losses to one third of gross growth pointedly re-emphasizes the desirability of shorter cycles and more discriminating localized cutting methods. Viewed in conjunction with the implication from State-wide growth estimates that reliance on conversion cutting produces yields averaging only 35 percent of site capacity, this excessive drain again focuses attention on the urgency of a management pattern balancing cutting with cultural treatment.

4. Redwood Growth Study

(Deferred)

5. Volume Tables

Revision of volume tables was started to meet expanding requirements of land managers, industry, and the current Forest Survey. The Forest Management Division is cooperating with the Survey to provide volume tables and taper tables by form class for the major coniferous species, seeking more accurate volumes for the age-density classes used in the Survey.

Improvement in accuracy, as well as in local application to small samples involved in sales by estimate, is sought by incorporating form factor in terms of Girard's form class. Preliminary work indicates that changes in Girard's volume table construction methods will be necessary for adaptation to local custom in height classification and utilization, and to tall timber. First results show that taper bears an unexpectedly strong curved relation to form class for large timber, but that the use of average (straight line) tapers may still be feasible. Because form-class tables reflect differences in volume caused by variations in stand structure, the new tables promise more uniform accuracy than currently used site-class tables.

6. Planting and Forestation Studies

Prompted by supposed imminence of expansion in planting, the survey of pine region administrative plantations covered 7,850 acres, or about two-thirds of the area rated successful by the standard criterion of 40 percent survival. Preliminary results indicate that too few trees were planted, that the standard of success is much too low, and that condition of surviving trees must also be taken into account. About 90 percent of the plantation area examined had less than 300 live trees to the acre and nearly 50 percent had less than 200 surviving trees. Nearly 80 percent of the area had less than 200 trees per acre in satisfactory condition. On the basis of numbers, and especially tree condition, burn plantings were somewhat superior to brushfield plantations. Animal damage and brush competition were the principal contributors to low survival and poor vigor of trees. In brushfields where 30 to 40 percent of the cover had been cleared by stripping, the shrubs retained or had regained control of all but 15 percent of the area.

Tenth year records from a large experimental brushfield plantation revealed over-all survival to be only 14 percent. The combined burning and stripping treatment resulted in 30 percent survival, whereas burning alone resulted in only 7 percent, and stripping alone, only 5 percent survival. Damage attributed to rabbits was severe and was not alleviated by a resylstrychnine spray treatment.

A test of root pruning in nursery stock showed that stock pruned to 6 inches in place at one year had at time of outplanting nearly the maximum number of lateral roots and nearly as many woody, durable lateral roots as standard 1-1 stock. If continuing survival tests are favorable, a portion of transplanting costs might be saved.

Fifth year records of a ponderosa and Jeffrey pine seed- and stock-grade experiment sustain preliminary findings of only minor advantages in field growth and survival attributable to large seed. Trees originating in the large component of seedlings and transplants now have little advantage over medium grade stock, but exceed small grades by 10 percent in survival and 6 inches in average height. About 60 percent of the obvious dominants came from large transplants.

Chemical eradication of planting-site shrubs with 2,4-D indicate that "bear clover" (Chamaebatia foliolosa), prevalent on good pine lands, may be subject to temporary control for a period long enough to admit tree reproduction, seeding or planting. Chemical eradication experiments on a more adequate scale having been undertaken by the Division of Fire Research and the Office of Blister Rust Control, these tests are maintained at minor supplementary status.

A seed collecting zone map prepared in 1945 has met with favor in practice; hence, a Station release is now being processed.

7. Recommendations for Desirable Practices

The growth report for California, prepared in 1945, was revised in form to include the forestry program that would be required to attain the estimated potential timber yields. Appearance of the State

district committees' forest-practice recommendations made release of the suggested program desirable, and the estimates were made available for the use of the American Forestry Association, State Chamber of Commerce, and Governor's legislative programs.

Recommendations of the committees are simple in nature. Progressive improvement in cutting practices may be expected as acceptance of their principles becomes more widespread. The Division hoped that reporting yields attainable by somewhat more adequate measures might aid in such improvement. Rapidly increasing numbers of sawmills last year, coupled with depletion of good merchantable second growth since the beginning of the war emphasize the urgency of adopting constructive cutting measures.

8. Assistance to Management Agencies

A developing pulp industry, destined to attain considerable proportions, led to requests for volume-table, converting-factor, yield, and operating information of types not previously required in this region. Accordingly, the Division cruised and marked a small area of cut-over land. This work gave a preliminary idea of the volume of pulpwood that might result from improvement cutting in mixed stands. It also provided information to incorporate in working plans for new research.

Expanding national forest sales accompanied by intensified interest in improved practices stimulated other requests for: Reviews of forest inventory procedures, suggestions on safeguarding watershed values, and means of improving sugar pine silviculture in balance with blister rust control.

Ways to make research more effective in extension work by channeling material to the numerous action agencies were discussed with Assistant Regional Forester Swingler and Extension Forester Metcalf.

9. Other Activities

Appropriation of new funds not contemplated when the plan was written made it possible in 1946 to strengthen important work on cultural studies in young stands. Long-proposed as part of the forest management research at the Station, that work was especially timely in 1946. Its timeliness may be sharply focused simply by contrasting current status of California timber with a few conditions listed in this report. On one hand, very little well-stocked second growth is available in the State, and most of it is of poor condition or low quality. On the other hand: Current cutting is producing only 35 percent of site capacity; sawmills have increased to over 800; a developing pulp industry will make new demands; rapid extension of national forest cutting necessitates intensive cultural treatment; and money spent for blister rust, fire, or other control is not balanced by expenditures for reproduction, stand improvement, or better yields.

With these facts in mind, the Division used the first part of the fiscal year to plan strengthened research on young stands. Closely related cutting, forestation, and mensuration studies were directed toward starting field experiments in spring of 1947.

Improvement and intermediate harvest cutting will be the subject of field trials in young-growth ponderosa pine, true firs, and mixed stands. Preliminary work completed in 1946 included: Tentative selection of areas at Blacks Mountain and Challenge Experimental Forests; review of pruning, thinning, and growth literature and of past cutting experiment records; guide cruises in mixed second-growth stands; removal harvest cutting from some of the selected areas at Blacks Mountain; and preparation of the plan for the Blacks Mountain study.

Plans for 1947

The outlook with respect to funds and personnel is not favorable to undertaking additional new lines of research in 1947, but the need for intensifying management in the best sugar pine areas clearly indicates where future amplification of research should be centered. The 1947 plan is to press to completion the following projects started in 1946:

1. Blacks Mountain ponderosa pine conversion cutting. Establish the final cutting test series, logging approximately 5 MM board feet.

2. Prepare management recommendations for mixed types from results of long-term plots.

3. Complete growth predicting chart revision.

4. Complete volume table revisions.

5. Report results of plantation surveys with recommendations. Continue minor going experiments and start growing stock for later tests of species previously receiving inadequate attention.

6. Establish field trials of stand improvement in young growth. Re-examine series of older thinning plots.

7. Assist in planting tests of hybrid stock, if undertaken.

8. Continue assistance to various forestry agencies in applying research results.

FOREST GENETICS

(W. P. Stockwell, Chief of Division)

The 1946 work program for Forest Genetics was designed to cover the following activities:

1. Mass production of hybrid seed for field planting trials and study of methods.

2. Crossings among the early flowering closed cone pines for phylogenetic study -- to the extent pollen and seed trees are available.

3. Continued pollen storage tests.

4. Continued oleoresin analysis of pine species.

The results of the year's work will be given in terms of these objectives.

Activities and Accomplishments

1. Mass Production of Hybrid Seed

Many requests for hybrid seed to be tested in the field encouraged the Division to start a mass production program. Most of the other Forest Experiment Stations, Region 5, and a few industrial groups have asked for seed. Their requests emphasize the fact that increasingly intensive forestry in the United States will make increasing demands for practical benefits from research. A number of the pine hybrids developed at the Forest Genetics Institute have been tested at Placerville for several years and several of these seem worthy of more extensive field trials.

Testing hybrids under forest conditions will provide an effective demonstration of practical value to genetics research. It may lead to forests better suited to the requirements of timber industries. Accordingly, mass production of hybrid seed was started in June and July and resulted in the placing of 1102 bags. (Used to protect flowers being pollinated, the bag is the most convenient measure of work until hybrid seeds are ripe. Assuming successful pollination, each bag will produce from 150 to 1,000 hybrid seeds, depending on species, variations between individual trees, and number of cones per bag.)

Nine of the principal crosses, in 985 bags, consisted of hybrids that had shown favorable characteristics in earlier, small-scale tests. The remaining 117 bags consisted of small numbers of crosses which were thought to merit at least small-scale field tests. The following tabulation lists the mass production crosses and the number of bags of each:

Seed parent	Pollen parent	Number of bags
Pinus ponderosa	P. scopulorum	300
P. ponderosa	P. arizonica	50
P. ponderosa	P. apacheca	50
P. ponderosa	others	58
P. Jeffreyi	hybrid (Jeffreyi x Coulteri)	450
P. Jeffreyi	P. scopulorum	25
P. Jeffreyi	P. arizonica	25
P. Jeffreyi	P. apacheca	25
P. Jeffreyi	others	29
P. monticola	P. strobus	30
P. monticola	others	30
P. Murrayana	P. Banksiana	30
	Total	1102

One new hybrid included in this list is showing particular early promise, that obtained by fertilizing P. ponderosa with P. apacheca pollen. The hybrid at two years is not as tall as P. ponderosa but is heavier, has a thicker stem and a deeper and more extensive root system. Should these characteristics persist, and should future growth rate equal or approximate that of P. ponderosa, a form of particular value for timber production might result.

2. Crossings of Closed-cone Pines

Crossings of closed-cone pines were continued by Stockwell, Cumming, and H. L. Mason (University of California) as part of the phylogenetic studies and to explore possibilities of new timber producing forms. Because of its early flowering habit, crosses can be made in this group without interfering with the pollination program in the timber-pine group whose flowers mature later in the season. Another advantage arises in that closed cones of this group permit seed collections over a longer period of time than other groups.

The group is especially fitted for phylogenetic study because it comprises only 18 generally recognized species, all represented in the Eddy Arboretum. Detailed study of closed-cone pines may provide a pattern for similar study of other groups of pines. Of particular practical value is the fact that this group contains the fastest growing species in the genus Pinus: radiata, patula, canariensis, and pinaster.

It is becoming increasingly evident that the program of pine hybrid development must be based upon sound, detailed knowledge of the phylogeny of the genus. Hybrids having hybrid vigor or other valuable characters result from crossing species within rather narrow limits of relationship, while crossings of species representing either closer or more distant relationships have given little promise of practical results.

The closed-cone pine crossing program for 1946 resulted in 19 pollination attempts representing 137 bags. The list is as follows:

Closed cone pines - 137 bags

Seed parent	Pollen parent
Pinus attenuata	Pinus remorata
P. contorta	P. Murrayana
P. contorta	P. remorata
P. contorta	P. halepensis
P. halepensis	P. radiata
P. halepensis	hybrid attenuradiata
P. halepensis	P. remorata
P. halepensis var. brutia	P. remorata
P. halepensis var. brutia	hybrid attenuradiata
P. halepensis var. brutia	P. radiata
P. muricata	P. remorata
P. muricata	hybrid attenuradiata
P. muricata	P. attenuata
P. muricata	P. halepensis
P. Murrayana	P. muricata
P. Murrayana	hybrid attenuradiata
P. Murrayana	P. Bolanderi
P. Murrayana	P. halepensis
P. Murrayana	P. sylvestris

3. Pollen Storage Tests

Storage and transportation of pollen under conditions which maintain its viability materially aid the hybridization program. Possibilities for the future are even greater, in that it will permit pollination of trees in their native habitat, carefully selected for form and vigor. Duffield and Mirov continued pollen storage tests during 1946. Later publication of the results is planned, but more work is considered necessary before this is done.

One indication of the value of results from this study is of interest. Methods developed by the study enabled viable pollen of the hybrid P. peuce x P. strobus to be successfully shipped by airmail from Denmark to the Forest Genetics Institute at Placerville, through the cooperation of Dr. Syrach-Larsen.

The studies will also help guide conversion of the present concrete seed storage room into a refrigeration room where seed and pollen can be stored for future use. This highly desirable project would establish the first "pollen bank", aid in carrying out the crossing program at the Institute, and be of great value if other regions or agencies seek pollen for their own pine breeding program.

4. Oleoresin Analysis of Pine Species

Continued according to plan during 1946, oleoresin analysis conducted by Mirov and colleagues developed new and interesting phases. Chemical analyses allow drawing relationship lines between Pinus groups and in many cases permit distinguishing between closely related taxonomic entities. For instance, the oleoresin of P. Torreyana shows marked resemblance to that of the white pines. As a result of this knowledge, P. Torreyana pollen will now be tested on white pines as well as yellow pines in relationship studies.

Jeffrey pine is chemically closer to Coulter and Digger pines than to ponderosa. P. strobus and P. monticola are quite different chemically, and so are P. Murrayana and P. Banksiana. P. attenuata, P. radiata and P. muricata are similar but distinctive. These are all very significant facts to the taxonomist.

Analyses of oleoresin from P. Torreyana, P. Coulteri and P. muricata were completed in 1946. Results with P. Coulteri were published during the year; those for P. Torreyana and P. muricata are now in manuscript form and will be published during 1947.

5. Other Activities

New timber pine crossings and repeat timber pine crossings are normal parts of the Forest Genetics program, although not specifically mentioned among the objectives for the year. On the basis of expanding knowledge of phylogenetic relationships within the genus and suggestions for desirable types of hybrids from many workers in the field of reforestation, Righter and assistants attempted 17 new crosses of timber-pine species, representing 228 bags. The list is as follows:

New timber pine crosses - 228 bags

Seed parent	Pollen parent
Pinus echinata	hybrid (echinata x caribaea)
P. echinata	hybrid (echinata x caribaea)
hybrid (echinata x taeda)	self
hybrid (echinata x taeda)	P. taeda
hybrid (Jeffreyi x Coulteri)	P. Coulteri
P. Lambertiana	P. ayacahuite
P. Lambertiana	P. halepensis
P. Lambertiana	hybrid (peuce x strobus)
P. monticola	P. ayacahuite
P. monticola	P. koriaensis
P. monticola	hybrid (peuce x strobus)
P. monticola	P. Torreyana
hybrid (Murrayana x Banksiana)	P. Banksiana
hybrid (Murrayana x Banksiana)	P. Murrayana
hybrid (Murrayana x Banksiana)	self
P. ponderosa	hybrid (Jeffreyi x Coulteri)
P. ponderosa	P. washoensis

The attempted crossing of P. Lambertiana and P. monticola with the hybrid P. peuce x P. strobus is of particular interest in relation to the program for control of white pine blister rust. According to Dr. Syrach-Larsen, the P. peuce x P. strobus hybrid has shown practical immunity to the rust in Denmark, growing under conditions in which P. strobus and P. monticola were killed or severely damaged. P. peuce is known to be highly resistant to the rust, while P. strobus is susceptible. The possibility of developing a hybrid combining the rust resistance of P. peuce with the form and growth rate of P. Lambertiana or P. monticola, designed for use in western United States, will be explored.

Repeat timber-pine crossings were attempted to confirm earlier results or to try again crossings previously unsuccessful. This undertaking resulted in 26 attempted pollinations representing 322 bags, as shown in the following list:

Repeat timber pine crossings - 322 bags

Seed parent	Pollen parent
Pinus echinata	P. glauca
P. echinata	P. taeda
P. Jeffreyi	P. apacheca
P. Jeffreyi	P. Coulteri
P. Jeffreyi	hybrid (echinata x taeda)
P. Jeffreyi	P. glauca
P. Jeffreyi	hybrid (Jeffreyi x Coulteri)
P. Jeffreyi	P. ponderosa
P. Jeffreyi	P. taeda
P. Lambertiana	P. Armandi
P. Lambertiana	P. strobus
P. monticola	P. Armandi
P. monticola	P. strobus
P. Murrayana	P. Banksiana
hybrid (P. Murrayana x P. Banksiana)	mutual uncontrolled
P. ponderosa	P. apacheca
P. ponderosa	P. arizonica
P. ponderosa	P. Coulteri
P. ponderosa	P. echinata
P. ponderosa	hybrid (echinata x taeda)
P. ponderosa	P. Jeffreyi
P. ponderosa	P. Murrayana
P, ponderosa	P. scopulorum
P. ponderosa	P. taeda
P. ponderosa	P. washoensis

Other jobs were undertaken to the extent of available time. Results of the analysis of the transect plantations were embodied in a special report. A study of relative susceptibility of introduced pines to the native turpentine beetle and pitch moth at Placerville, made by the Division of Forest Entomology, Bureau of Entomology and Plant Quarantine was completed and a report prepared. Improvements were made in various techniques of pollen collection, flower forcing, pollen germination and other similar steps in the methods of hybridization. Studies and experimental development of special safety equipment for use in tree climbing were begun.

Plans for 1947

1. Continue mass production of hybrids for large scale tests, producing seed of those hybrids which have proved above average in the nursery.

   a. Concentrate on Pinus ponderosa crossed with vars. scopulorum, P. apacheca, and P. arizonica, particularly the scopulorum cross in an effort to produce a fast-growing, frost-hardy hybrid for the area from the Sierra Nevada to the Kansas plains.

b. Work with Lake States Station and University of Minnesota to produce seed of lodgepole-jackpine hybrid for trial in that region.

c. Produce seed of Jeffrey x Coulter hybrid and of crosses involving the hardy P. washoensis.

2. Cooperate with Region 5 in developing plans for large scale field tests of promising hybrids.

3. Continue the Institute's search for better pines, attempting new crosses among the best timber producing species of pines in line with new knowledge of phylogeny and new demands from other regions.

4. Continue repeat crosses as needed to confirm previous work.

5. Continue phylogenetic studies to provide basic data needed for developing the pine hybrid program.

6. Continue oleoresin analyses, to provide information valuable for chemists -- new compounds and separating valuable known compounds -- as well as to supply information on species relationship which will help guide the crossing program.

7. Study methods of mass production of hybrid seeds to increase efficiency and to reduce costs. This to include further development of safety measures for tree climbing, with the cooperation and assistance of Training and Safety, Regional Office.

FOREST FIRE RESEARCH
(C. C. Buck, Chief of Division)

Objectives

The 1946 program of work was laid out with these primary objectives:

1. Fire Damage Appraisal: Complete the southern California project undertaken in 1945 in collaboration with the Forest Influences Division.

2. Chemical Control of Forest Vegetation:

   a. Test the effectiveness of chemical sprays for controlling brush under spring and early summer growing conditions, using a series of plot experiments comparable to late fall tests conducted in 1945.

   b. Complete a joint Forest Products Laboratory-Station manuscript summarizing recommended uses of chemicals in control of forest vegetation.

3. Ignition Time and Ignition Temperature Study: Continue basic laboratory studies of forest fire combustion with CPS assistance at the San Dimas Experimental Forest for duration of the CPS program.

4. Forest Fire Behavior and Control: Resume field and laboratory studies on a prewar scale as soon as men and facilities become available.

Activities and Accomplishments

1. Fire Damage Appraisal

Compilation of damage estimates in the southern California fire damage study was approximately half finished rather than completed according to plan. Change in completion date was caused largely by inability to predict the rate at which the hydrologic analyses, used as the primary basis for damage estimates, could be made for the various watersheds concerned. To speed this part of the work Countryman spent almost the entire year with the Influences Division, and the application phase was slowed accordingly.

Under Fons' immediate direction compilation of damageable values on all four forests was largely completed. Expected damages to on-site values resulting from flood and erosion after fire were compiled for the 114 drainage units which make up the Angeles and San Bernardino forests. These damages alone have been found to be as high as $150 per acre.

Estimates of the volume of debris expected downstream following fires of different sizes have also been compiled for these 114 units. Large quantities of debris coupled with high costs for storage or removal will make this item alone a major part of the total damage from fire on many units.

2. Chemical Control of Forest Vegetation

During the spring months Blanchard sprayed ammonium sulfamate and 2,4-D (sodium 2,4-dichlorophenoxyacetate) on brush plots throughout the State, replicating those plots treated in the fall of 1945. Although ammonium sulfamate killed the foliage of all species, sprouting shrubs soon put out new shoots; even among the non-sprouters killed, this chemical proved too costly to have much practical value for large-scale control operations. While 2,4-D generally was more effective in spring than in fall, experiments showed that, like other chemicals, it has many limitations in field use. Blanchard prepared a brief report on results of this and other studies for publication in the April 1947 issue of Fire Control Notes.

While much was learned from chemical treatments of brush plots in 1945 and 1946, results were not complete enough for definition of effective control practices. To provide urgently needed answers to some of the more important questions, Blanchard continued studies of 2,4-D through the year. Work has been directed primarily toward selection of the most effective forms of 2,4-D for different control problems, and toward development of satisfactory field techniques.

The joint Laboratory-Station manuscript summarizing recommended uses of chemicals for control of forest vegetation was temporarily shelved. This action was taken because it was felt that current publications should contain specific information on 2,4-D. Results of recent research at this Station and elsewhere make early completion of the manuscript feasible.

3. Ignition Time and Ignition Temperature Study

Laboratory study of ignition time and fuel temperature at ignition was continued at the San Dimas Branch Station under Fons' direction until close of the CPS program. Analysis of the data collected was brought up to date before close of the CPS camp, but some additional work is yet needed to complete the study and to prepare the results for publication. When completed this unit study is expected to contribute materially toward more thorough application of known principles of combustion to forest fire behavior problems. Its major immediate value, however, will be to serve as a basis for planning additional field and laboratory studies needed to provide fire control personnel with practical working guides to expected fire behavior.

4. Forest Fire Behavior and Control

Field and laboratory studies of forest fire behavior and control on a prewar scale were not resumed during the year as planned. Lack of enough men and facilities for effective research made it desirable again for the Station to accept financial assistance from the Region for "service-type" work. The following six jobs were accomplished under this program:

Fons re-computed meteorological averages for all California national forest and national park fire danger stations. This was

done to bring the averages in line with changes in instrument exposures resulting from the field inspections Fons and Buck made during the preceding two years.

New tables of Fire Danger were prepared for the new standard 20-foot above-ground wind measurements that have replaced the old 9-foot exposures. These were distributed to the field before opening of the 1946 fire season.

During March and April, Buck and Fons conducted seven 2-day fire danger training meetings for 130 field officers. In addition to all California district rangers and Supervisor's fire staff officers, key fire men from the National Park Service, State Division of Forestry and Los Angeles County attended the meetings. Purpose of the training course was to bring these men up to date on research results in fire behavior and fire danger rating and on the application of what is known in these fields to the job of managing and protecting forest lands. Material presented was most enthusiastically received.

Two new sets of fire danger rating instructions were prepared under Buck's direction for field use. The first consists of simplified instructions for fire danger rating station observers. The second contains instructions for dispatchers and supervisory personnel responsible for determining and using fire danger in Region 5. These are being reproduced at the Station and will be distributed to the field before the 1947 fire season.

Increased financial returns to the livestock industry accompanied as usual by a demand for more intensive use on mountain and foothill ranges has again made controlled burning an important element in California forest protection. Individually and in collaboration with the Influences Division, Buck has given considerable time to study of the problem and to participitation in meetings with State and Regional personnel. There has been vociferous demand from Federal, State and local sources for facts on which to base both State and Federal controlled burning policy. But facts as to the effects of fire, particularly on California foothill lands, are not sufficient to be of significant value in demonstrating either benefits or losses from range burning. The need for an answer has become acute periodically ever since the start of organized protection limited the general practice of uncontrolled range burning. It will continue to be acute until an adequate research program can be carried through. The problem has been given high priority in the Fire Division long-term program, but considerable time may elapse before actual work can be undertaken.

Countryman completed installation of new equipment together with reorganization of assembling and testing facilities used by Region 5 in the manufacture of fuel moisture indicator sticks for all the western regions. He prepared an office report describing all operations in sufficient detail that a uniform product can be assured despite changes in operating personnel.

Plans for 1947

1. Fire Damage Appraisal: Complete the project, with Fons and Countryman devoting practically full time and Buck spending half time or more on this work.

2. Chemical Control of Forest Vegetation:

   a. Continue spray studies on a limited scale, emphasizing intensive experiments on a limited number of California brush species and confining treatments to the salts and esters of 2,4-D.

   b. Complete the text for Laboratory-Station publication, with Bruce and Buck summarizing the recommended uses of chemicals for different forest vegetation control problems and Blanchard assisting in preparation of the section on use of translocated chemicals.

3. Ignition Time and Ignition Temperature Study: Obtain laboratory data necessary for completion of the study. Fons will devote any time that can be spared from the fire damage appraisal to this study; results will be published as soon as all data can be completely analyzed.

4. Forest Fire Behavior and Control: Resume field and laboratory studies of long-term program as rapidly as men and facilities become available.

FOREST ECONOMICS
(A. E. Wieslander, Chief of Division)

Objectives

Newly organized early in the year, the Division of Forest Economics scheduled the following jobs for 1946:

1. Reappraisal Project: Wind up the Forest Survey's part by preparing a final report on its findings — up-to-date figures on forest areas, timber volumes, and vegetation types.

2. Forest Survey: Prepare a preliminary plan and develop techniques for starting the inventory phase. Recruit, train and organize personnel. Start the survey as soon after July 1 as possible.

3. Census and RPS: Conduct the annual lumber census in cooperation with the Bureau of Census; prepare monthly reports on factors affecting lumber production in pine and redwood regions, and report a monthly statistical survey of lumber productions and stocks in the redwood region. (RPS work to be done as long as requested and financed by CPA)

4. Vegetation Survey: Complete a survey of a sample county, cooperating with State Board of Equalization, and develop a method of using the classification for tax assessment.

5. Forest Economics Research: Make at least a start toward organizing a general program of research in forest economics.

Activities and Accomplishments

In the new Division the entire field of forest economics work was handled, under Wieslander's direction, by four sections: (1) Inventory, Commodity Drain, Census, and RPS — under Burks; (2) Sampling Design, Volume Tables, Growth, and Non-commodity Drain — under Hasel; (3) Photogrammetry and Resource Analyses — under Jensen; (4) Timber Consumption and Requirements, plus Economic Aspects of Timber, Water, and Range Utilization — under Vaux. Specific activities were:

1. Reappraisal Project

Begun in March 1944 by the Forest Service, the Division's part of the timber reappraisal was completed March 1, 1946, by publication of Forest Survey Release No. 4. To supplement this report of forest areas, timber volumes, and vegetation types, two statewide maps at a scale of 16 miles to the inch were also prepared. One map shows the vegetation-type classification and the other the timber-cropland classification; they are distributed in blue-line print form. Both report and maps are finding important uses locally. For example, the California Forestry Study Committee has leaned heavily on the data in preparing its report to the 1947 State Legislature.

2. Forest Survey

Allocation of funds this year enabled starting the Forest Survey on a full-scale basis. Preparatory work already completed, including an

experimental line-plot survey and the development of aerial-photo techniques, helped get the Survey under way.

Inventory. - Work on the inventory phase, currently the primary job of the Division, was carried out about as planned. The preliminary plan was completed and approved and essentially the full quota of field men were on the job promptly after July 1. Specifically, the more important accomplishments were as follows:

a. Built up and trained a competent staff of 29 people, including 14 field men trained as skilled technicians in aerial-photo interpretation and volume sampling.

b. Classified the age and density of timber stands on a gross aerea of 1,800,000 acres and transferred 600,000 acres of this to base maps.

c. Measured 294 fifth-acre plots, completing volume sampling for 500,000 acres of commercial forest land. Started an analysis of the plot data, together with time records that were kept to aid in revising the preliminary inventory plan. This analysis now reveals remarkable agreement with the original estimate of number of plots required to attain desired sampling accuracy.

d. Measured 413 hardwood trees as a basis for determining number of trees needed to prepare a volume table for each species, and for the possible construction of these tables. Combining certain species or using existing volume tables for other species from other regions were also considered in this study. For coniferous species, the Forest Management Division is cooperating to provide volume and taper tables and growth prediction data.

e. Developed the technique for transferring forest-land classification from aerial photos to base maps — a process involving the removal of area distortion on the photos, change of scale, and use of base maps of widely varying accuracy. This transfer is essential to the California plan, being a necessary preliminary to the location of sample plots and determination of acreages. It also provides a means of producing classification maps useful for local administrative and other purposes.

f. Made considerable progress, with the advice and assistance of an expert from the Southern Station, in designing a system for computing areas, volumes, and growth from our maps and sample plot data by means of tabulating machines.

Data obtained and experience gained in connection with those six items of work will provide a basis for revising the inventory plan in terms of methods and intensities that will be permitted under our financial limitations. This was the primary objective for 1946, and it set the stage for real progress in inventory field work during 1947.

Drain. - A work plan was developed covering the survey of commodity drain to start in 1947. The plan involves a canvass of all operators

producing sawlogs, poles, piling, and pulpwood, and provides for a sample survey of producers of other forest products. It calls for coordination of the work with the census of 1946 lumber production. Methods and limits of accuracy were standardized with those to be used in the Pacific Northwest and Northern Rocky Mountain regions so as to insure comparability of data for the entire West. The plan was designed to produce a regional drain estimate with a maximum sampling error of 5 percent.

Requirements. - A tentative general plan for the analysis of lumber requirements has been blocked out. To date, emphasis in the planning has been on the exploration of available data, comparison of alternative methods of approach, and development of survey techniques applicable to requirements studies in the region. Because of the limited facilities available for requirements work the plan is designed to make maximum use of secondary sources of information. These sources will include building-permit surveys by U. S. Bureau of Labor Statistics, the 1940 housing census, Bureau of Agricultural Economics and Agricultural College data on agricultural production, box specifications from National Wooden Box Association, and the Census of Manufactures. In addition, work plans have been prepared for surveys of wood used per consuming unit in residential construction and on farms, and a study of the effect of population changes on lumber requirements has been started.

3. Census and RPS

The annual lumber census was completed and the RPS work was continued through the entire year. Results of the lumber census were reported in the Station's Forest Research Note 50. In the RPS work, 12 monthly reports for each of the pine and redwood regions were prepared, discussing such factors as operating capacity, manpower, equipment and supplies, raw materials, weather, cost-price relationships, and management policies. They also discussed briefly current lumber stocks, supplies and production outlook. In addition, statistical reports for the redwood region were prepared giving estimates of the monthly lumber production and lumber stocks on hand. Significant findings of this census and RPS work are summarized as follows:

Annual lumber production for 1945: 2,261 million board feet, 8½ percent below the 1944 peak.

Estimated 1946 production: 2,416 million feet, about 7 percent above 1945 despite a 30 percent decrease in the redwood region resulting from a year-long strike at major plants. Factors offsetting the strike: new sawmills, increased output at existing mills, adequate manpower, and more plentiful equipment.

Number of active sawmills increased 79 percent, from 457 in 1945 to 818 in 1946: pine region sawmills increased about 70 percent; redwood region, about 105 percent. About 80 percent of all new units were mills cutting less than 1 million feet annually; the remainder cut 1 to 10 million annually. Of all mills active in 1946: 27 cut 25 million feet or more per year, 74 cut 5 to 25 million, and 717 cut less than 5 million.

4. Vegetation Survey

Field study of a sample county, to develop a method of using vegetation classification for tax assessment, was postponed with the consent of the State Board of Equalization. Delay was caused primarily by the need to assign practically the entire Division to the Forest Survey. Prospective State Division of Forestry cooperation in the Survey would permit detailed vegetation mapping outside the national forests, largely meeting the objectives of the sample county study. The Board of Equalization is still keenly interested and will cooperate as soon as conditions permit.

5. Forest Economics Research

During the last quarter of the year, preliminary work was started on research in economic aspects of forest management and utilization. This initial effort was restricted to a problem analysis for the economics field. Though still incomplete, this analysis emphasizes the importance of the following economic conditions: (1) waste of resources and effort evidenced by large areas of idle and understocked timberland of potentially high productivity; (2) waste caused by inefficient use or non-utilization of some forest products — such as material from stand improvement operations or from stands of so-called "inferior" species; (3) lack of adjustment between forest and ranch economies resulting in continued pressure for depletion of forest ranges; and (4) inadequate delineation of those land areas on which major efforts for timber or forage production should be concentrated.

6. Other Activities

The Division helped start Forest Survey work at the Northern Rocky Mountain Station, detailing Burks to that Station over two months to serve as acting chief of its Division of Forest Economics. Jensen helped conduct the service-wide training course on the use of aerial photos for forest inventory and management purposes — a course held at Petersham, Mass., under direction of the Northeastern Station and in cooperation with Harvard University.

The Division also worked with the State Division of Forestry to plan for a more intensive land classification on certain areas outside national forests. Funds for this project may be provided by the State Legislature now in session. The overall program was laid out to include: (1) reflying some areas to obtain new aerial photos; (2) preparing better base maps for some areas; (3) mapping forest and other vegetation types in greater detail; and (4) increasing volume sampling. Reflying and base map work will be handled entirely by the State. In the mapping and volume sampling, State crews will be pooled with those of the Station so that the work can be done at a maximum saving in cost.

Plans for 1947

1. Forest Survey

Inventory

a. Prepare a field manual covering classification of aerial photos, field sampling procedures, and species-type and site mapping operations.

b. Complete the analysis of variance of all plot volume data and crewtime records, to get more precise information on the number and allocation of plots as well as to improve accuracy of estimates where possible.

c. Revise the inventory work plan to reflect experience as to costs, adequacy of sampling, new methods or procedures, and rate of progress. Plan to be submitted to Washington by April 1.

d. Complete the field inventory (mapping and sampling) of at least half of the remaining commercial timberland areas.

e. Crystallize procedure for compiling areas and volumes by punch cards; install certain punch card equipment by fall; place accumulated data on cards; and complete the compilation of area and volume statistics for at least two main timbered counties.

f. Develop procedures for deriving area measurements from maps, and cooperate with the BAE in assembling maps showing land ownership.

g. Plan the Survey's county statistical and sub-region analytical reports; prepare Siskiyou and Trinity County reports for release; and assemble general descriptive material for one or more sub-region reports.

h. If State funds become available, cooperate with the State in planning for survey intensification, in recruiting and training State personnel, and in starting the more intensive survey involving certain areas outside the national forests.

Drain and Requirements

i. Conduct the yearly commodity drain survey for all forest products except fuelwood, fence posts and split products.

j. Prepare supplemental plan for conducting the drain survey of items excluded under "i.". Plan to be submitted to Washington by February 15.

k. Submit to Washington by April 1 a preliminary plan of special studies for the evaluation of woods waste as a factor in total commodity drain.

l. Collaborate with Pacific Northwest and Northern Rocky Mountain Stations in submitting recommendations to the Washington office by July 1 regarding the adequacy of present volumetric converting factors for minor forest products generally reported in units other than board feet or cubic feet.

m. Complete preliminary working plan for the requirements phase of the Survey, and conduct the planned studies of wood used in residential and farm construction.

n. Prepare preliminary plan and start work for estimating non-commodity drain.

2. Census and RPS

a. Take the annual census of lumber production and stocks, omitting data on lumber distribution and stumpage and log prices. Obtain new data on log production and other forest products needed for the commodity drain phase.

b. Continue RPS work until March 31, or longer if required.

3. Forest Economics Research

a. Complete the problem analysis for the forest economics field.

b. In cooperation with other Divisions, identify major economics content of existing and potential work center projects.

c. Guided by the problem analysis, select work center projects of highest priority and develop work plans for their economic phases.

FOREST UTILIZATION SERVICE
(L. N. Ericksen, Chief of Division)

Objectives

Improving forest products utilization in California is the general aim of the Forest Utilization Service Unit. With that aim in mind, its 1946 objectives were:

1. Continue the study on air seasoning of white fir.

2. Start experimental work in California on kiln drying of white fir, provided that the Forest Products Laboratory could assign necessary personnel and that suitable mill cooperation and kiln facilities could be obtained.

3. Arrange for industry cooperation and assist the Laboratory in the study of better white fir utilization methods, including: (a) container design, (b) veneer production and markets, and (c) sawmill design adapted particularly to white fir lumber manufacture.

4. Enlist the help of the Laboratory in study of kiln drying California hardwoods; conduct air-seasoning experiments in the field; investigate working qualities of hardwoods.

5. Maintain close contact with industry organizations and operators to stimulate better utilization practices, including: (a) reduction of sawmill waste through manufacture of rough or semi-finished parts, (b) re-manufacture of low grade material, (c) use of mill waste and secondary species in chemical and pulp products, and (d) use of California hardwoods.

Activities and Accomplishments

1. Air Seasoning of White Fir

Work on air seasoning of white fir was continued in a series of tests carried out during the past summer. In piles taken down in May, lumber air-dried from October 1945 to May 1946 showed a low moisture content and considerable checking and splits due to cupping. An experimental pile put up in May and taken down the first part of August showed moisture content of around 9 percent in spite of one inch stickers and very close spacing in the course.

2. Kiln Drying of White Fir

A series of experimental dry kiln runs was carried out at the Madison Laboratory to determine optimum schedules for drying of white fir with a minimum of degrade. While tests were limited to a narrow range in variety of wood (test material came from three trees off the Blacks Mountain Experimental Forest), the material involved was dried without particular difficulty using conventional temperatures and other kiln conditions.

3. White Fir Utilization

Experimental work was conducted at the Laboratory on nailing white fir orange boxes. Material used was taken in part from white fir shipped to Madison in log form, sawed there, and dried in the kiln drying experimental work. Other nailing tests were conducted on boxes made at the Laboratory from commercial shook. Briefly, these tests showed that satisfactory orange boxes could be made from the type of white fir tested. For best performance, the material had to be properly dried to a moisture content of from 9 to 18 percent, and boxes constructed with ends and centers having rails placed across the end grain. These rails permit nailing into side grain wood on all edges. One-piece and multiple-piece ends and centers, requiring nailing into end grain, showed weaknesses due to splitting and nail pull.

Utilization of white fir in the past has been almost entirely in the form of lumber. In order to explore its usefulness as veneer and plywood, arrangements were made to have some work done along these lines at the Forest Products Laboratory.

Since red fir (Abies magnifica) is entering definitely into the utilization picture in this region and is frequently associated with white fir in timber stands, several logs of both species were shipped to the Laboratory. Red fir is being sold and manufactured in combination with white fir and as loggers move back to higher elevations, they encounter pure stands of red fir. Because it is increasingly cut, red fir was included in the experimental work on veneer and plywood.

Rotary cut veneer was cut and dried at the Laboratory with good success under conventional commercial conditions. Plywood panels were laid up and appeared to have a quality which should make them suitable for a number of uses in the industrial and construction fields. Work is also being done to determine the suitability of these veneers for container use.

To explore another use for white fir, a number of round and split white fir fence posts were treated at the Laboratory, using a cold soaking treatment with Pentachlorophenol in an oil vehicle. They are being included in the series of fence post exposure tests carried out on a number of woods. Information obtained in treating these posts has been useful here as a guide in discussions with persons who are considering treating white fir posts locally.

4. California Hardwoods

Started at the request of this Division, Laboratory study of several California hardwoods resulted in veneer and plywood which have aroused widespread interest among manufacturers and timber owners. Possibility of veneer manufacture has had special appeal, and the Forest Utilization Service has received many requests for information on methods for manufacture and seasoning of these species that up to the present have been neglected.

Material of four species — tanoak, madrone, California laurel, and chinquapin — was sent to the Madison Laboratory for research along several lines. During the year both kiln drying and veneer cutting

were studied. It was found possible to kiln dry green madrone and laurel with very little drying defect in less than two weeks. Some checking and honeycombing occurred in drying tanoak even under very mild conditions. Chinquapin was found to be most refractory, considerable checking and excess shringage due to collapse occuring under the mildest of kiln conditions.

Work on cutting of rotary veneer from these woods was encouraging as regards cutting quality of the wood and drying characteristics. Since the test logs were not selected for veneer quality, little significant information was obtained on probable yields of veneer per M feet of logs. A portion of the veneer was made up into plywood panels. Although not stained and finished, the tanoak, madrone, and laurel panels appear to have a grain and figure that should make them attractive to the furniture and allied fields. They may also find use in wall panels. While chinquapin may give the best yield of veneers because of the good size and form of the tree, it does not have grain and figure as attractive as the other woods. Considerable interest has been expressed by people in the industry upon seeing the veneer and plywood from these woods.

5. Industry Contact

Plans for the establishment of a pulp mill in the State crystallized during the year. The first unit of the plant, to be located at Antioch on the lower Sacramento river, is expected to be in operation early in 1948. It is planned as a semichemical kraft plant to manufacture corrugating material for containers. Additional units will be erected to manufacture liners by the sulfate process. Tentative plans provide for the use of wood in several forms, all of which have a definite bearing on utilization practices in the Sierra Nevada, from which the mill's wood supply is expected to come. The semichemical unit can use sawmill waste in the form of slabs and edgings, thinnings from improvement cuttings, salvage material from logging operations, and standing timber. It is understood that the mill contemplates using any of the coniferous woods from the Sierra region, although there is some question as to the suitability of incense cedar. To round out the information on its pulping characteristics, second growth cedar was shipped to the Forest Products Laboratory for experimental pulping. Second growth cedar is of particular interest since it is present in substantial percentages in some of the young stands where improvement cuttings are contemplated. Its exclusion for pulp purposes may adversely affect the utilization of thinnings from these stands of timber.

Arrangements were made for personnel from several Forest Product Laboratory divisions to visit typical logging, lumber manufacturing, wood using, and processing operations during the year in connection with research being carried on in these fields. They included survey of: Special methods and types of equipment used in logging; special types of mills designed for rapid production which might reduce costs of manufacturing white fir; plants cutting veneer for containers and battery separators; and wood preservation plants.

Throughout the year the Unit received requests from timber owners and operators, from wood users, and from the general public for information on a wide variety of subjects involving the handling, protection and use of wood, both domestic and foreign.

Plans for 1947

1. Seasoning of Local Woods

a. Arrange a field course in kiln drying.

b. Continue seasoning tests on white fir and start new tests on red fir.

c. Continue tests on California hardwoods, particularly some of the oaks. Seek assignment of Laboratory technicians with a portable experimental kiln to conduct research where these woods are found. (Although there are almost no data available on air or kiln drying methods, operators are increasingly interested in utilization of California hardwoods.)

2. Wood Utilization

a. To add to the knowledge of properties and working qualities of local hardwoods, start Laboratory experiments on suitability of the oaks for veneer and plywood comparable to work done in 1946 on four other hardwoods.

b. Continue study of white- and red-fir use for boxes; using veneer cut at the Laboratory, conduct field tests of typical agricultural boxes made of white- and red-fir veneer.

c. Working with Region 5, develop a simple type of wood preserving plant suitable for use on national forests for the treating of poles to be used on the forests.

3. Industry Contacts

a. Acquaint prospective manufacturers with results of 1946 Laboratory work on cutting veneer from tanoak, madrone, California laurel, and chinquapin.

b. Continue to work with Fibreboard Products, Inc., and with other Forest Service units on utilization phases of the Antioch pulp mill; follow up Laboratory study of pulping incense cedar.

c. Develop plans for and complete a survey of wood waste accumulating at primary plants — the quantity, character, availability, etc. — for use as a guide in considering the feasibility of establishing new industries.

d. Continue to promote better utilization practices through wide-spread contacts with industry organizations and individual operators.

RANGE INVESTIGATIONS

(M. W. Talbot, Associate Director, In Charge)

Work in this Division, directly concerned with the management of more than half of the total land area of the State, falls logically into three subdivisions: (1) grazing management in the mountains; (2) grazing management in the foothills; and (3) reseeding. Objectives for 1946, activities and accomplishments, and plans for 1947 are highlighted separately for each project.

Mountain Ranges (A. L. Hormay, Project Leader)

Objectives

The year's effort was directed at two major objectives:

1. Obtaining the third season's field measurement of cattle weights, plant growth and forage utilization in a study of the comparative grazing value of cut-over pine-timber range and adjoining mountain-meadow range.

2. Stressing compilation and analysis for publication of all data collected at Burgess Spring Experimental Range since 1936 on the grazing value of cut-over pine-timber range for beef cattle in northeastern California.

In addition, limited time was allotted to completing certain phases of laboratory experiments on the germination of bitterbrush seeds — a forage plant study of widespread interest because of the possibility of increasing this valuable browse species through reseeding.

Activities and Accomplishments

All of the foregoing objectives were met. Especially significant findings obtained by work on the major objectives were:

1. Timber-meadow comparisons

The third year's results of the comparative grazing value of pine-timber and meadow types follow the general pattern of the first two years. Cattle gain just about the same weight in both types. Within rather narrow limits the gains in each type follow the same trends. The major difference between the types is in grazing capacity, not nutritive value. This answer to a question long debated, bears directly on management of mixed timber and meadow range allotments and private holdings, where satisfactory use of forage on timbered slopes usually has been obtainable only at the price of overgrazing the open flats and meadows. In establishing the fact that timber forage is nutritious feed, the recent findings show need for more control of range livestock, not only as a means of conserving areas subject to over use but also in the interest of efficient utilization and meat production on the range as a whole. Analysis of all results at the end of the coming season should throw fresh light on these and related points of considerable importance in managing and coordinating the use of these summer grazing lands.

2. Grazing value of cut-over pine-timber range

About 75 percent of the data collected at Burgess Spring since 1936 was compiled by the turn of the year. Check data on the effect of logging on forage were obtained during the summer, through re-measurement of 1164 quadrats, established in 1936. The lack of these data has been one of the main factors blocking earlier analysis and publication of the Burgess Spring results. The findings are planned for publication in a U.S.D.A. Circular.

This work has brought out the high grazing value of cut-over timber range for beef cattle. It has indicated that more efficient use and therefore greater production can be obtained from the type by more intensive management involving timing grazing so as to obtain maximum benefit of the nutritive value of the forage and periodic resting to encourage reproduction of the more desirable species and to maintain the vigor of the stand.

Plans for 1947

1. Prepare a manuscript of the Burgess Spring results to date.

2. Carry the timber-meadow comparison through the fourth and probably the final year; revise Research Note No. 44 issued in 1945; and start round up of the four years' work ending this fall for semi-technical publication.

3. Collaborate with Cornelius in preparation of reseeding analysis for northeastern California.

Foothill Ranges (J. R. Bentley, Project Leader)

Objectives

In general it was planned to restrict field work in grazing management to the few critical observations and photographs required to maintain continuous records on the long-time studies. All remaining effort was to be devoted to preparing of data for publication, to make results widely available.

More specifically, the first half of the year was allotted for completion of a major forage manuscript; the second half for shorter papers and for replanning portions of the research program with cooperators.

Activities and Accomplishments

Although work in the foothill ranges conformed to the general objectives for 1946, the specific schedule could not be met — partly because some unscheduled time was required on brush burning and reseeding projects, but chiefly because of rapid dwindling to zero of the CPS program. This program supported much of the operation and maintenance of the physical plant along with computing and field assistance vital to the research projects.

Analyses and summaries of all data were completed for studies on the effects of grazing intensity on forage and soil. The conclusions reported in the 1944 and 1945 annual reports were strengthened by additional results from analyses during 1946. For example, the analyses show that winter growth of forage is influenced not only by the degree of utilization of the preceding forage crop but is affected as much by certain physical conditions of the soil surface litter. The analyses further show (1) the extent to which soil surface conditions have been determined by past grazing use; and (2) guides to the field recognition of these conditions.

Revealed also is the extent to which the land types in the pastures (as previously described for the San Joaquin Experimental Range) account for differences in their productivity. Potential productivity, computed from land types, was compared to the present production as determined by clipped samples and stocking-utilization records. This analysis indicated that a pasture which has been closely grazed since 1936 was producing in the period 1943-1945 only approximately 75 percent of its potential. Pastures which have been more conservatively grazed are producing at about the computed capacity.

Summarization of all data on climate, on forage growth and on yield was completed and analysis was started. This analysis is expected to advance our present meagre knowledge on the relation of climatic data and plant growth, in terms of land management. A technical bulletin on this specific subject is contemplated, in addition to the use of selected portions of the data required for a clear understanding of sections of the semi-technical circular on results of intensity of grazing, now in preparation.

Observations and a limited number of measurements were continued on the fertilizer plots at the San Joaquin Experimental Range. Good increases in forage were obtained from the residual fertilizer effects of superphosphate and gypsum applied in February, 1944 and 1945. Results from all tests since 1942 were summarized into an office progress report and a popular article was published in the California Cattleman.

While not originally planned for 1946, the need for cooperation with the State of California on brush burning tests in the upper foothills of Madera County developed during the year, following decision by the State to extend the controlled burning program to Madera County. Participation by our range group was invited, and was believed highly desirable for two reasons: (1) the widespread interest in this controversial problem, and (2) the highly favorable cooperative relations with both the State and the livestock industry. The project was undertaken by the State Division of Forestry, the California Agricultural Extension Service, and the Division of Agronomy, University of California. The Sierra National Forest cooperated. Seedings, photo stations and observations, for which the Station has assumed responsibility, will be concentrated on the Clark Administrative Site study area and the "Ahwahnee Burn" area. The study has both management and reseeding aspects.

The increased number of visitors during the year, including stockman groups, national forest officers and college classes, as well as scientists from other states and countries, required about 10 percent of the time of the technical staff.

Plans for 1947

1. Complete a manuscript covering the effects of grazing intensity on forage and soil.

2. Devote most of the latter part of the year to inter-agency planning (chiefly with the University of California) for the next phase of the pasture experiments. It is hoped to have Chapline's help on this in connection with his fall inspection.

3. Maintain essential fractions of the reseeding, fertilization, and brush control studies.

4. In general, limit field work to the notes, photographs, and measurements required to fill gaps in the above data.

5. Collaborate with Cornelius on reseeding analysis.

Range Reseeding (D. R. Cornelius, Project Leader)

Objectives

Range reseeding research for 1946 was aimed chiefly at starting spot studies to supply information needed in analyzing the problem and preparing a broad working plan for the State — the foundation for a sound experimental program. Conspicuously lacking were some guiding facts on such things as which sites offer most chance for improvement by reseeding, the most promising forage species, and the best methods of land preparation, seeding, and management.

Activities and Accomplishments

1. Northeastern California

Field plot plantings were made in the spring and fall on sagebrush and meadow types on mountain rangeland, on the Modoc, Lassen, and Plumas National Forests, in close collaboration with the California Region and the separate forests. Sagebrush types selected included three distinct planting sites, characterized by different soils and vegetation. Similarly, meadow types were represented by four different classes of planting sites.

In general, survival of seedlings during the first summer was fairly good, considering the dry spring. Two areas were damaged by grasshoppers. From these preliminary tests the following species appeared promising on the big sagebrush site: Agropyron cristatum, A. dasystachyum, A. intermedium, A. trachycaulum, Bromus inermis, B. marginatus, Elymus glaucus, Hordeum bulbosum, Sitanion hystrix, Poa ampla, Medicago sativafalcata, Lupinus calcaratus, and Purshia tridentata. Eight species appeared most promising on meadow areas: Bromus inermis, Phleum pratense, Arrhenatherum elatius, Dactylis glomerata, Bromus marginatus, Elymus glaucus, Phalaris arundinacea, and Poa ampla.

Several species and strains of native and introduced grasses and a few legumes and browse species are undergoing initial test. The planting sites are alongside the administrative pilot-plot plantings of 20 to 200 acres; one boundary fence encloses both.

Additional pilot-plot plantings were made by Region 5 on other sites on the Modoc, Lassen, Plumas, Shasta, and Los Padres National Forests. Field examinations were made jointly by technicians of the Station and Region first to select sites desired for reseeding study, and later to observe early effects of seedbed preparation, and seedling emergence in the fall (1945) and spring (1946) plantings.

Administrative plantings in fall and spring indicated that drilling where feasible was more successful than broadcast seeding. In general, fall seeding of grasses and shrubs gave better results. In contrast, spring seeding of dryland alfalfa was more successful than fall seeding. These variations in initial findings emphasize the need for specific information in advance of extensive and costly plantings.

2. Central California

Reseeding studies in this area were handled chiefly from the San Joaquin Experimental Range. Twenty-five species of grasses and legumes were included in foothill field tests on three sites: (1) sloping valley plains, elevation about 400 feet, with poor, heavy hardpan soil and deficient rainfall; (2) lower foothills, elevation about 1,000 feet with fair, shallow sandy loam soil; and (3) upper foothills, elevation 2,500 feet with deep fertile sandy loam soil. Mountain meadow sites on the Stanislaus and Sierra National Forests are located at elevations of 5,000 and 6,000 feet.

Early results indicate that Harding grass is the best species thus far tested for better sites, namely, lowland soils in all three elevational zones. Certain bromes and ryegrasses show promise for the upper foothills. The two native needlegrasses, Stipa cernua and S. pulchra, have done best on the fair and poor sites (slope soils), with perennial veldt grass, weeping lovegrass and smilo showing some possibilities.

The summary of adaptation trials of 184 species and strains was completed and published as Research Note 48, by Bentley.

Cooperative work was started on grass reseeding following brush burning in Madera County (see Foothill Ranges).

Plans for 1947

Work on the reseeding project will be largely suspended until June, during the educational furlough of Cornelius to complete requirements for the Ph.D. at the University of Nebraska. Following his return, chief emphasis will be placed upon:

1. Checking results of last year's plantings.

2. Obtaining additional specific information for problem analysis by —

a. Continuance of site studies and field tests to determine adaptation of species.

b. Comparison of methods and time of land preparation to reduce competition from sagebrush and other plants and to provide a

more suitable seedbed.

c. Cooperation with the University of California and other agencies in field testing of new strains of native or introduced plants for range reseeding at higher elevations.

FOREST INFLUENCES
(C. J. Kraebel, Chief of Division)

Objectives

Planning to concentrate its major effort in 1946 on two lines of work, the Division of Forest Influences also included among its objectives maintenance of three continuing endeavors. Its two primary projects were:

1. Fire damage appraisal: Complete the Influences part of this project, cooperating with the Fire Research Division.

2. Analysis of data: Continue analysis of accumulated data from the San Dimas and North Fork centers.

Other commitments included:

3. Operation of San Dimas Experimental Forest: Maintain continuity of hydrologic and other records on the Forest as far as available manpower permits.

4. Cooperation in-service: Continue consulting service, supply research data, and plan experiments for execution on the Los Angeles Flood Control Project: Provide consulting service, supply research data, and make special studies as needed for the Flood Control Survey Division.

5. Other cooperation: Supply information and segments of research data to public agencies: Conduct visiting groups over the Experimental Forest to explain the research program.

Activities and Accomplishments

1. Fire Damage Appraisal

Hydrologic analyses were completed for the Angeles and San Bernardino National Forests, and were started for the Cleveland and Los Padres National Forests. These analyses included computing the sizes of floods by various frequencies of occurrence on each of 130 appraisal units (watersheds or parts thereof). Computations were made for each of three conditions of vegetation: (1) fully recovered from previous fire effects, (2) freshly denuded by fire, and (3) intermediate — representing changes from present conditions to complete recovery. Erosion rates were also computed for all units under the same three vegetative conditions.

Typical of the results of these analyses are the following figures for the Big Santa Anita watershed, embracing 10.9 square miles:

> Once in 100 years the flood peak will equal or exceed 389 cubic feet per second per square mile under normal cover conditions. But the first year after complete denudation of the watershed by fire, this flood peak would be doubled, to 778 cubic feet per second per square mile.

At the other extreme is the flood peak which could be expected to occur 16.6 times per year: 0.85 cubic feet per second per square mile; this peak would be multiplied 34 times by complete denudation. Parallel erosion rates are as follows: normal annual rate is 3,800 cubic yards per square mile; the first year following complete denudation and under the same "100-year" storm, this erosion rate would be increased 35 times to 133,000 cubic yards per square mile.

It was also determined that on the average major flood peaks reflect fire effects for about 70 years, while erosion rates generally return to normal in eight or ten years after a burn.

Reports and maps describing and classifying the forest and chaparral cover, the soils, and the geological structure of the four national forests involved in the project, were prepared on the basis of extensive field reconnaissance done in 1945. This information, in combination with the rainfall and streamflow data, was required in the foregoing analyses for delineating areas of equal or similar hydrologic behavior.

2. Analysis of Data

Hydrologic Analysis of Watersheds. - The massive job of analyzing scores of watersheds for the fire damage appraisal has occupied almost the full time of Rowe and Storey. To broaden the application of their work, they used segments of San Dimas data, thus continuing the analysis of accumulated material.

Precipitation. - Analysis of precipitation data from five comparative networks of vertical and tilted facet rain gages on the San Dimas Experimental Forest was carried forward by Hamilton. Preliminary summaries of recent data continue to strengthen the case for the greater accuracy of tilted facet gages placed according to a prior analysis of the watershed topography. The results are being shaped for a report covering networks in Monroe and Wolfskill watersheds.

Streamflow. - Storey began the study of accumulated San Dimas streamflow data, but the full-scale job of analysis cannot be undertaken until completion of the fire damage appraisal project.

Chaparral Succession. - The analysis of vegetational succession data, collected from more than forty quadrats established immediately after burning of chaparral cover, has been almost completed by Horton. Some of these quadrats have been under observation for twenty years, and the findings have been tested by extensive examinations of vegetation throughout southern California. Publication of those findings is planned for a Department Circular.

Lysimeter Studies.- Two studies relating to hydrologic phases of the lysimeter project, were completed and the results published in two papers by Colman.

In addition the succession of vegetation which followed the initial sowing of soft cheat grass in the lysimeters five years ago has been analyzed and described in an office report by Horton. He prepared another report on the results of experimental planting set out from 1942 to 1945 in border areas outside the lysimeters to determine the best method of establishing permanent cover in the lysimeters in 1946.

Soil Moisture Cycle. - Analysis of data on soil water storage was continued by Colman, concentrating attention upon the detailed soil moisture sampling carried on by Rowe at North Fork and Bass Lake between 1934 and 1945. The North Fork study included three plots, one with undisturbed brush cover, one burned annually, and one trenched and maintained bare of vegetation. Biweekly soil moisture records supplemented by measurements of rain, interception, and runoff, have made it possible to account quite accurately for all phases of water disposition. Results indicate that differences in percolation through the three-foot soil mass can be accounted for primarily by differences in surface runoff induced by plot treatment.

At Bass Lake, three plots similarly treated had soil six feet deep and of finer texture than that at North Fork. The vegetation is pine and fir transition forest. The data indicate that evaporation from the trenched bare plot is less than evapo-transpiration from the other two. Runoff, however, is greatest on the bare plot, and intermediate on the one burned annually. As a result, the trenched bare plot does not experience percolation through the soil mass any earlier than the others; its higher water content during the dry season introduces no benefit in terms of increased percolation.

Soil Stabilization in Burned Watersheds. - Mustard was first sown in 1932 as an inexpensive "first-aid" treatment for erosion control. In various burns sown by the Forest Service in southern California from 1932 to 1937, plots had been installed and operated by the Station to measure the effect of mustard cover on erosion and runoff, and the rate of soil erosion on fire-denuded slopes. Review and analysis of the plot data were resumed this year, after a practical cessation of effort since 1937.

After mustard was established, only two-thirds as much erosion occurred on five sown plots as on five unsown plots. Erosion rates were high the first and second years, dropping rapidly thereafter. The maximum erosion rate for a single storm was 48,000 pounds per acre (dry weight), and the maximum seasonal total was 59,000 pounds per acre. From the 4th to the 14th year erosion on the plots was practically nil.

On one pair of plots, intensive records of runoff were kept for two years after accidental burning. The first year after the fire, the sown plot showed 10 percent less total seasonal runoff than the unsown plot; the second year it showed 21 percent less. Maximum runoff in a single storm the first year was 24 percent of rainfall on the sown plot and 27 percent on the unsown plot. Total runoff was greatest the first year, amounting to 11 percent of total rainfall on the sown plot and 12 percent on the unsown plot; in the second year these figures were 1.07 percent and 1.35 percent for the sown and unsown plots respectively. In both years, peak flows from the sown plot averaged 25 percent lower than the corresponding peak flows from the unsown plot.

Since the runoff plots were not calibrated prior to this accidental fire, it may not be concluded that the reduction of runoff on the sown plot was caused entirely by mustard. These differences might have resulted either from the increased infiltration capacity of the sown plot caused by the increase in organic matter added to the soil by two generations of mustard plants, or from inherent differences in the plots. Further experimentation is needed to obtain conclusive results.

3. Operation of San Dimas Experimental Forest

Full operation of the Forest was continued through the 1945-46 hydrologic season, ending September 30, 1946. By that date the certainty of early closing of the Glendora CPS Camp made it necessary to suspend about 80 percent of the field work on the Forest. Under the curtailed program, it was decided to limit the collection of data to two intermediate watersheds, the large lysimeters, and the master climatic station at Tanbark Flat. Measurements of erosion were to be obtained from seven small watersheds in Fern and Bell Canyons, so long as reservoir capacities would permit.

Monroe Canyon in Big Dalton Drainage, and Wolfskill Canyon in San Dimas Drainage, were chosen for the two intermediate watersheds because they well represent their parent drainages, and because special studies have been under way in each for some time. Records from these watersheds, coupled with inflow records at Dalton and San Dimas reservoirs, will help in maintaining the essential thread of continuity of the hydrologic history of the Experimental Forest.

Planting of the large lysimeters to five native species (wild buckwheat, chamise, ceanothus, scrub oak, and Coulter pine) was done in the spring of 1946. Survival in most of the tanks was satisfactory, but some replacements will be required in 1947.

4. Cooperation in-Service

Rowe and Storey were frequently consulted by Los Angeles Flood Control Project personnel for assistance in estimating future erosion rates and flood frequencies. Horton also planned and assisted in starting a series of short-term experiments for improving depleted cover on the Project.

Numerous training sessions were held by Rowe and Storey to instruct Flood Control Survey staff men in the procedures of hydrologic analysis. Research data were supplied to aid in the hydrologic and damage phases of the Santa Ana and Santa Maria surveys, and segments of the survey work were reviewed by Influences men.

Working closely with the Regional Office, Kraebel and Dunning examined the effects of current logging practices upon watershed conditions in a typical west side Sierra Nevada timber sale area. Their joint memorandum recommended measures for correcting unsatisfactory practices by reducing soil disturbance and preserving the maximum of natural conditions along stream beds. The contract for a new sale in an adjacent area provides for the recommended work.

Advice and data, including computations of probable flood peaks and erosion rates for 22 watershed units of the Angeles National Forest, were given the Supervisor for his use in improving watershed management plans of that forest.

5. Other Cooperation

The Division assisted several agencies with advice or research data. In connection with controlled brush burning in California, the State Forester requested the Station's cooperation with a special State committee employed to review and summarize all available information on the effects of such burning on runoff, soil erosion, and vegetation. A considerable part of the material placed at the committee's disposal by the Station has been used in two reports to be published by the State. The report on runoff and erosion was reviewed in the manuscript stage by members of the Influences Division.

Officials of the East Bay Municipal Utility District asked help with their resumption of cover improvement activities on watersheds tributary to several municipal reservoirs in the Coast Range. Prior to the war the Division helped with advice and occasional lots of seed or surplus planting stock. This year, advice was needed on the selection of species for various sites, and on the rehabilitation of an abandoned nursery.

Numerous office reports containing erosion data were lent to the Soil Conservation Service for use in estimating sedimentation rates for proposed reservoirs in the Sacramento-San Joaquin basin of California.

A paper describing the vegetation of the mountains in San Bernardino County was prepared by Horton for inclusion in a report by the U. S. Geological Survey on the major watersheds of the county.

Hamilton's assistance was requested by the Los Angeles City Engineer in planning the distribution of facet rain gages on watershed land within the Los Angeles City limits.

The end of hostilities in the war brought to the San Dimas project a large number of visitors who drew heavily on the time of the technical staff. Several groups, including representatives of the U. S. Engineers and the U. S. Geological Survey, came especially to discuss the method of hydrologic analysis of watersheds developed by Rowe.

6. Activities in the Sacramento River Basin

General review of the water resources, developments, and plans in the Sacramento River Basin, an unscheduled project, was undertaken in July as an important step in working out a problem analysis for Forest Influences research. Noteworthy progress included: Assembly and review of numerous publications, reports, and maps; contacts with Federal and State agencies involved and with the watershed management staff of the Regional Office; compilation of a "working tool" map showing major existing and proposed water projects in the basin; assembly of hydrologic data needed for the problem analyses; and field examinations of sample watersheds in both the Coast Range and Sierra Nevada,

including the Sierra Snow Laboratory maintained cooperatively by the U. S. Weather Bureau and the U. S. Engineer Corps. This activity was suspended at the end of the year, but Munson's office reports were completed for future reference when this project can be resumed.

7. Other Activities

Because of special requests or unforeseen changes in time and money available, the Division worked on several other projects not scheduled in the original plans for 1946. At the request of the Washington Office Colman has been preparing a semi-popular paper to help clarify the controversial brush-burning issues in California, with specific relation to Forest Service fire-control policy in this region.

Now almost complete, work on Colman's electrical soil moisture meter has been concentrated on determining the temperature coefficient of the soil unit. Re-design of the meter and soil unit is under way to make use of an improved type of temperature detector, called a "thermistor," developed by the Bell Telephone Laboratories. This change will both simplify the units and facilitate their manufacture. The thermistors are now under test.

Requests for soil units of the meter have been received from many agencies, but the manufacture of a large number of the units anticipated in last year's report was not realized because of loss of CPS personnel at San Dimas. A few units have been supplied to local cooperators, and more may be available for others in 1947.

Plans for 1947

1. Fire Damage Appraisal

a. Complete the hydrologic analysis and erosion estimates of remaining appraisal units and prepare a detailed office report on the methods employed.

b. Prepare final reports covering vegetation, soils, geology and hydrology for each of the four southern forests.

c. Prepare for publication a paper describing the method of hydrologic analysis.

d. Submit for publication a paper describing the method used for extensive surveying of forest soils.

2. San Dimas Center

a. Continue hydrologic analysis of accumulated San Dimas data.

b. Complete cover plantings on lysimeters.

c. Prepare final report on rainfall studies on Monroe and Wolfskill watersheds after the end of the rainy season.

d. On July 1, unless the outlook changes, drop back to smaller program entailing concentration on analysis and publication of accumulated data, and meeting minimum requirements in cooperation and extension.

3. Soil Moisture Cycle

a. Complete analysis of North Fork and Bass Lake data and combine with results of similar studies at San Dimas for publication.

b. Complete laboratory tests of the electrical soil moisture meter and arrange for commercial production and interagency field tests.

4. Miscellaneous

a. Complete the paper on brushland burning in California for departmental publication.

b. Prepare a paper on vegetation succession following fire in chamise-chaparral.

c. Complete analysis of plot data relating to effect of mustard sowing in burned areas and prepare results for publication. Revise and reissue Research Note 37, Directions for Sowing Mustard.

d. Continue in-service and other cooperation as far as possible without excessively retarding work on other plans.

FLOOD CONTROL SURVEYS
(David M. Ilch, Chief of Division)

Objectives

During the first half of 1946 objectives were limited while awaiting a statement of Departmental policy and the allotment of funds. One man was assigned to review reports left unfinished during the war, participate in planning for resumption of survey work, and assist in organizing the new Division.

When revival of flood control activities was approved, those preliminary objectives were expanded to include four specific activities delineated by reorganization of flood control surveys within the Department of Agriculture:

1. Preliminary examination and report of watersheds authorized by Congress.

2. Advance studies to obtain information and data essential to the orderly conduct of future surveys.

3. Flood control surveys to determine for authorized watersheds the sources of accelerated erosion and runoff that contribute to flood problems and the most feasible measures for producing flood control and sediment reduction benefits.

4. Participation in Soil Conservation Service flood control surveys.

Activities and Accomplishments

Early 1946 work on planning for a new Division led to quick dividends when employment and reassignment of personnel to flood control activities was approved in June. Recruitment continued through to September, when the last of the technical men reported for duty. By the end of the year four sections were handling functions of the Division: (1) Advance studies, under Davidson; (2) Land Use, under Beeson; (3) Hydrology, under Fishback and Fittinger; (4) Damage Appraisal, under Maevers.

The Division's first assignment was the review of the unfinished Santa Maria survey report preparatory to revision. However, instructions to proceed with a special survey and report on the Wrightwood mudflow area halted the Santa Maria revision. Further work was postponed until 1947, because of reconsideration of proposed plans for the main stream by the Bureau of Reclamation and the Corps of Engineers.

The survey and report on the Wrightwood mudflow, located northwest of San Bernardino in the Angeles National Forest, was completed in October and submitted to Washington for review. Additional revisions and final mimeographing of the report were undertaken in December preparatory to submitting the report to the Washington office and other agencies for review. Investigations in the area and analysis of flood and mudflow damages to Wrightwood village were instrumental in developing a plan of protection designed to reduce the damage hazard in this mountain recreational settlement.

In November the Division started review of the Santa Ana report, prepared under the direction of the Soil Conservation Service in 1942. Revision of damage estimates and a thorough review of the hydrology were the first steps. Subsequent field examinations with Soil Conservation Service representatives resulted in the development of tentative programs for evaluation and analysis. Concurrently, study of the fire damage appraisal data, developed by the Forest Influences and Forest Fire Research Divisions, has been under way to determine their adaptability to survey requirements.

Review of the survey report of the Walla Walla watershed, in Washington, has been requested by the SCS, the agency responsible for its revision. The preliminary review has been made, and arrangements completed with Region 6 and the Pacific Northwest Forest and Range Experiment Station to undertake a thorough review of the wild land portions of the report preparatory to assisting in the revision of the report.

Advance studies, for which there was no counterpart in the prewar surveys, have been set up as a definite part of flood control investigations. The advance studies project was limited in 1946 to the collection and assembly of much-needed reference data, maps, and reports for the various watersheds scheduled for early survey. Compilation of reservoir statistics for the Pacific Coast basins, augmented by available records of deposition surveys, is being improved upon from time to time.

Several trips to the Pacific Northwest were made to discuss flood control survey plans with both Forest Service and Soil Conservation Service representatives, as well as Mr. G. T. Hudson, the USDA Representative on the Columbia River Inter-Agency Committee.

Plans for 1947

1. Preliminary Examinations

(No preliminary examinations are proposed for 1947 in view of the present backlog of watersheds approved for survey.)

2. Advance Studies

a. Complete survey work outlines for the San Diego, Santa Clara, and Ventura Rivers.

b. Assist the Soil Conservation Service in the preparation of the survey work outline for the Salinas River.

c. Investigate survey data requirements for the Sacramento, San Joaquin, and Willamette Rivers.

d. Continue maintenance of data and reference files on watersheds scheduled for investigation and survey.

3. Surveys

a. Complete interim reports for the Santa Ana River watershed as well as the Santa Maria River watershed report and the San Gabriel River watershed survey report.

b. Begin new survey of San Diego County group of streams.

c. Assist the Soil Conservation Service in the revision of the Walla Walla survey report.

d. Assist the Soil Conservation Service in the survey of the Salinas River watershed.

COOPERATING AGENCIES

During 1946, as in other years, material and scientific help from several agencies and individuals strengthened the Station's research program in many ways.

Close ties with the Administrative program of Region 5 benefited research as a whole as well as many of the specific projects. Noteworthy examples include: Transfer of qualified Regional personnel to the Forest Survey, speeding that work considerably; integration of Regional timber surveys with the Station's so that data are additive and interchangeable; cost saving help in the transfer of area classification from aerial photos to base maps. In addition, national forests responded with facilities and help wherever Station workers travelled in the forests.

University of California, our primary research cooperator, continued its important and valued assistance through close working relations between our Station and a number of University departments or divisions, including Agronomy, Animal Husbandry, Botany, Forestry, Genetics, and the Agricultural Extension Service.

Civilian Public Service camps for conscientious objectors provided assistance at the San Dimas Experimental Forest, the Institute of Forest Genetics, and the San Joaquin Experimental Range until the end of the program, as discussed in the Director's foreword.

Collaboration with staff members of California Institute of Technology, Stanford University, and the Carnegie Institution of Washington at Stanford advanced the work of the Institute of Forest Genetics in such projects as oleoresin analysis and physiological studies.

The Bureau of Entomology and Plant Quarantine, Department of Agriculture, continued cooperative studies vital to the solution of several forest management problems, especially at our Blacks Mountain and Institute of Forest Genetics Branch Stations.

Forest Survey work received benefit from several sources. Through arrangements with Dr. W. W. Wagener, consulting pathologist to Region 5, the Bureau of Plant Industry assigned Dr. J. W. Kimmey to help correlate decay with external indicators recorded on Survey plots. Adon Poli, Bureau of Agricultural Economics economist, will strengthen ownership aspects of the Forest Survey through his work on forest land ownership as it relates to forest resource data.

Cooperation of the State Division of Forestry aided many Station Divisions and will be of increased value if the State Legislature approves a recommendation of Governor Earl Warren. Governor Warren recommended an item of $100,000 for the fiscal year beginning July 1, 1947 to finance intensification of Forest Survey land classification on certain areas outside national forests. The undertaking would greatly increase the local value of the Survey in areas where forest land management problems are especially acute. The work would be performed by the State Division of Forestry, with the cooperation and advice of the Forest Survey.

In its efforts to promote better utilization, the Forest Utilization Service received valuable aid from a number of individuals and firms. Among these were Fruit Growers Supply Company, Susanville, who supplied commercial box shook; Winton Lumber Company, Long Bell Lumber Company, and Associated Lumber and Box Company, who supplied red fir and white fir, all for Laboratory tests. Jack L. Reveal, Farm Forester at Santa Rosa, and Arnold Wallen, Forest Technician for North Coast District of the State Division of Forestry, both helped supply California hardwoods for Laboratory experiments.

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Bernard M. Kirk
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*Stenographic staff members are listed according to major work assignments. Those indicated by * also serve divisions for which no stenographic service is shown.